IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

RICHARD W. ARNOLD ET AL.

Serial No. 09/845,344 (TI-27698.1)

Filed May 1, 2001

For: STUD-CONE BUMP FOR PROBE TIPS USED IN KNOWN GOOD DIE CARRIERS

Art Unit 2829

Examiner Asok K. Sarkar

Customer No. 23494

CERTIFICATE OF MAILING OR TRANSMISSION UNDER 37 CFR 1.8

I hereby certify that the attached document is being deposited with the United States Postal Service with sufficient postage for First Class Mail in an envelope addressed to Director of the United States Patent and Trademark Office, P.O. Box 1450,, Alexandria, VA 22313-1450 or is being facsimile transmitted on the date indicated below:

3-8-06

Jay M. Cantor, Reg. No. 19,906

Mail Stop Appeal Brief-Patents
Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

Sir:

DECLARATION OF JAY M. CANTOR

JAY M. CANTOR declares as follows:

1. That he is an attorney of record, Reg. No. 199096, and is the attorney who originally prepared the subject application;

2. That he has reviewed the attached Invention Disclosure entitled "Stud-Cone Bump" for Probe Tips used in Known Good Die Carriers;

3. That he prepared the subject application using the attached Invention Disclosure with consultation with one or more of the applicants;

4. That all redacted dates including the date of receipt of the attached Invention Disclosure are dated prior to April 24, 1998.

5. That the attached Invention disclosure fully teaches the invention claimed in the subject application for Letters Patent as well as providing a disclosure of the invention as claimed in the subject application in a manner "ready for patenting" in accordance with the dictates of the Decision of the United States Supreme Court in Pfaff v. Wells Electronics, 525 U.S. 55 (U.S. 1998).

I declare under penalty of Perjury under that the foregoing is true and correct on information and belief.

3-9-06
Date

Jay M. Cantor

GCH

To: Gary C Honeycutt <g-honeycutt@ti.com>
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Subject: Stud-Cone Bump for Probe Tips used in Known Good Die Carriers: Part 1
Attachment:
Date: [redacted] 3:17 PM

DOCKET NO. TI-27698

1. Please suggest a descriptive title for your invention:

"Stud-Cone Bump" for Probe Tips used in Known Good Die Carriers

2. What is the problem solved by your invention?

Presently the Known Good Die Carrier industry is limited by the pad pitch and number of bumps that can be placed economically upon a single temporary test carrier used to manufacture Known Good Die (KGD). TI has performed a great deal of development work upon this issue in the ARPA funded 474 pin MMS Test carrier project and the KGD/IE development work with Diamond Tech One in Austin, Texas. The 474 pin test carrier project demonstrated that the use of a polymer membrane with plated bumps would not be an easily developed technology. The TI team in its final report cited numerous improvements that the entire MMS system would need before interface could be made effectively with just 474 pins. A note here is in order, many of the devices that S/C has road mapped have over 500 pins. The Diamond Tech One studies, although technically promising in terms of solving the pad pitch problem, had to be discontinued because of DTO's financial needs to focus only upon manufacturing process that had a high return instead of developmental projects such a KGD bumps. TI has also worked with EPI, in Plano, Texas. They use a conductive polymer that is screened upon the ceramic membrane. This technology is limited by the pitch constraints of EPI's screening techniques which is pushed to the maximum at 4 mils. This is not good enough to support the newer generation of TI devices.

The second problem encountered is the cost associated with the procuring of membranes used to rout the signals in the Die Mate and KGD/IE test carriers. The membranes consist of conductive paths to the test contactor from conductive bumps that interface with the die product. In support of the test carrier business TI has utilized membranes from Micro Module Systems (MMS), Diamond Tech One (DTO), and EPI. In each case the cost of the membranes for low and medium volume carrier runs is greater than $50 per unit acquired to fit into the TI die carrier. When the membrane cost run greater that $20 per membrane for a low pin count solution such as the type that TI is presently working with EPI on the 16 Meg SDRAM the cost just for the test membrane makes the manufacture of low margin KGD using temporary test carriers uneconomical. The reason for the high cost for build ing test membranes belongs to outside suppliers who place their cost high for customers who purchase the membranes. Another associated high cost is the NRE associated with building the membranes at each supplier. NRE per membrane range from $10,000.00 to $25,000.00. When this is added to the per unit cost the business of low cost Known Good Die carriers becomes impractical from an economic standpoint. If TI had its own, easily manufacturable, TI internal method we could get the cost of building the test membrane below the targeted goal of $20 dollars per membrane.

2. What is your solution to the Problem?

The solution to this problem is to develop a bumping technology that will meet the pitch requirements of TI's evolving semiconductor products and can be placed upon a low cost membrane with conductive traces that mirror the test carrier requirements. TI has internally already developed the foundation for the bump; gold ball bond stud bumps. Stud bumps are capable of being produced to the tightest pitch that a gold ball bond can be placed on a semiconductor device. The stud bump has a fair degree of planarity, plus or minus 12 microns. This can be improved by coining the top of the stud bump with a hard metal surface. The stud bump is bonded to a low cost silicon or ceramic membrane that will fit into the Die Mate or KGD/IE carrier. In order to get compliance and coplanarity upon top of the stud bump for interface to the semiconductor device to be tested, the stud bump is coated with a solution of conductive polymer. The conductive polymer is the "Cone" portion of the "Stud-Cone Bump." The conductive polymer on top of the Stud Bump gives the bump the necessary compliance to conform to the surface of the semiconductor die to be tested. The conductive polymer is filled with silver flakes that form a jagged edge on top of the "Cone" that break the oxide present on the die bond pads. This technology was proven in EPI's usage of conductive paste for their KGD interface. The conductive polymer develops coplanarity across the surface of the test membrane the first time a device is loaded. The conductive polymers used are ones that are readily available from any number of suppliers such as Epoxy Tech, JIM or MI. TI can perform both the stud bump and cone application operations internally. The cost of designing and procuring the ceramic or silicon membrane for the carrier is low NRE less than $2000.00 with a unit price of $6.00 per unit. Stud bumping of the membranes is done with an available gold ball bonder. The cone is applied by dipping the tips of the stud bumps into a thin film of the conductive polymer. These are both inexpensive operations.

4. When was the solution first conceptually or mentally complete?
   Date: [redacted]

   The dates and drawings are documented with notes in the engineering note book of Richard Arnold for "Stud-Cone Bump Development."

5. What is the first tangible evidence of such completion?

The "Stud-Cone Bump IDEA Project" will prove out the concept during the Spring and Summer of 1998. The project will use the TI 16M x 16 CD/ SDRAM. The developmental project will consist of evaluating ceramic and silicon membranes with the stud bumps. The project will also evaluate 3 different conductive polymers from Epoxy Tech, JMI and QMI. By the end of the IDEA project the carrier development team will have the necessary data to provide the lowest cost most effective "Stud-Cone Bump."

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Proceed to Part 2 in next message

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Bcc:
Subject: Stud-Cone Bump: Part 2
Attachment:
Date: [illegible] PM

6. What is different about your solution, compared with other solutions to the same problem?

The bumping technology is the main difference. The "Stud-Cone Bump" uses a gold ball bonded stud bump as the foundation for the contact. On top of the Stud Bump base a cap consisting of conductive polymer is placed upon the tip of the bump upper surface. The stud bump base is generally 3.5 to 4 mils high. The stud bump is dipped into a solution of conductive polymer that covers the bump up to 2 mils from the base of the ceramic or silicon. The conductive polymer is filled with 75% silver flakes that have a hard sharp edge that when exposed on the tip of the "Cone's" upper surface serve as the interface between the die and the test carrier. The hard edges of the silver flakes also break any oxide build up on the die product so that conduction can occur at the bump surface. Other KGD test carrier bumping technologies rely upon electro-deposited bumps or screened on conductive polymers. Both of these technologies are excluded from success in the TI carrier technology road map for technical or financial reasons mentioned previously.

The substance of this invention lies in its utilizing proven technologies in the flip chip bonding field, stud bumping and polymer interconnection. Both of these technologies when used for a KGD application are unique. The use of a stud bump is already proven as a foundation for flip chips. The usage of polymer flip chip and KGD interconnection is already proven. However, no one has plans to use these two low cost technologies for KGD carrier bumping. When TI is able to supply this to the market via its proven Die Mate and KGD/IE carrier technologies a truly low cost adaptable carrier will become available.

7. What are the advantages of your solution?

The primary advantage will be the low cost to produce the test carrier membrane. The cost of the ceramic or silicon membrane will be a fraction of the cost for the polyimid or photolithography with silicon and ceramic membranes, presently utilized. The cost of building a bump will be the cost of a gold ball bond on a pad location. This is pennies compared to the technology intensive options presently available. Because of the technologies being utilized the membranes can be built inside of TI production or lab facilities.

The second advantage is the ease of manufacturing the membranes. The substrate will be built up with stud bump locations assigned. It is relatively easy to locate a gold ball bond for the stud bump base. The conductive polymer cone is applied by dipping the entire assemble into a solution of conductive polymer. This operation is a matter of developing a uniform film for dipping the tips of the stud bumps into. Once the Cone is applied the bumps are cured. The assembly is then ready to be place in the Die Mate or KGD/IE carrier assembly.

The third advantage is both Material and Controls and Semiconductor Group can use this approach to manufacture low cost KGD carriers. M&C will be enabled to work inside of TI property for the manufacture of its membranes for the KGD test carries it manufactures and S/C will have a very low cost carrier technology available in house to use to supply its KGD to the open

8. What TI products, processes, projects or operations currently implement your invention?

The plans are for Materials and Controls and Semiconductor Group to share in the application of this invention. M&C will sell Die Mates with this approach and S/C will uses this approach for KGD production. The prototype runs will utilize the TI 16 Meg SDRAM product.

9. What is the date of first implementation?

The IDEA project plan for Stud-Cone Bump development in the Spring of 1998 will develop the most cost effective approach for this technology. Copies of the IDEA proposal and the associated drawings are being forewarded to you for documentation of this project.

10. What record exists to prove this date?

The engineering note book of Richard Arnold for "Stud-Cone Bump Development" provides the records for this date. A copy of the pages that document this work will be forwarded to TI Legal.

11. Is there any future implementation planned?

Materials and Controls and Semiconductor Group plan to utilize the low cost solution for KGD carriers.

12. Has the invention been published or disclosed to any one outside of TI?

TI has disclosed this invention to Polymer Flip Chip Corporation under the NDA that exists between both companies.

13. Has a TI product incorporating the invention been publicly introduced quoted, sampled or shipped?

No

14. Was the invention conceived or first implemented in the performance of a government contract or subcontract?

No

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Proceed to Part 3 in the next message

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Bcc:
Subject: Stud-Cone Bump: Part 3
Attachment:
Date: [illegible] PM

THE INVENTION DESCRIBED BY THIS DISCLOSURE IS SUBMITTED PURSUANT TO MY EMPLOYMENT AGREEMENT WITH TEXAS INSTRUMENTS INCORPORATED OR A TI SUBSIDIARY (SPECIFY):
****

Has this disclosure been previously sent to the Patent Department electronically (unsigned)? Yes

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